From the Green to the Gene Revolution: A 21st Century Challenge

Norman E. Borlaug

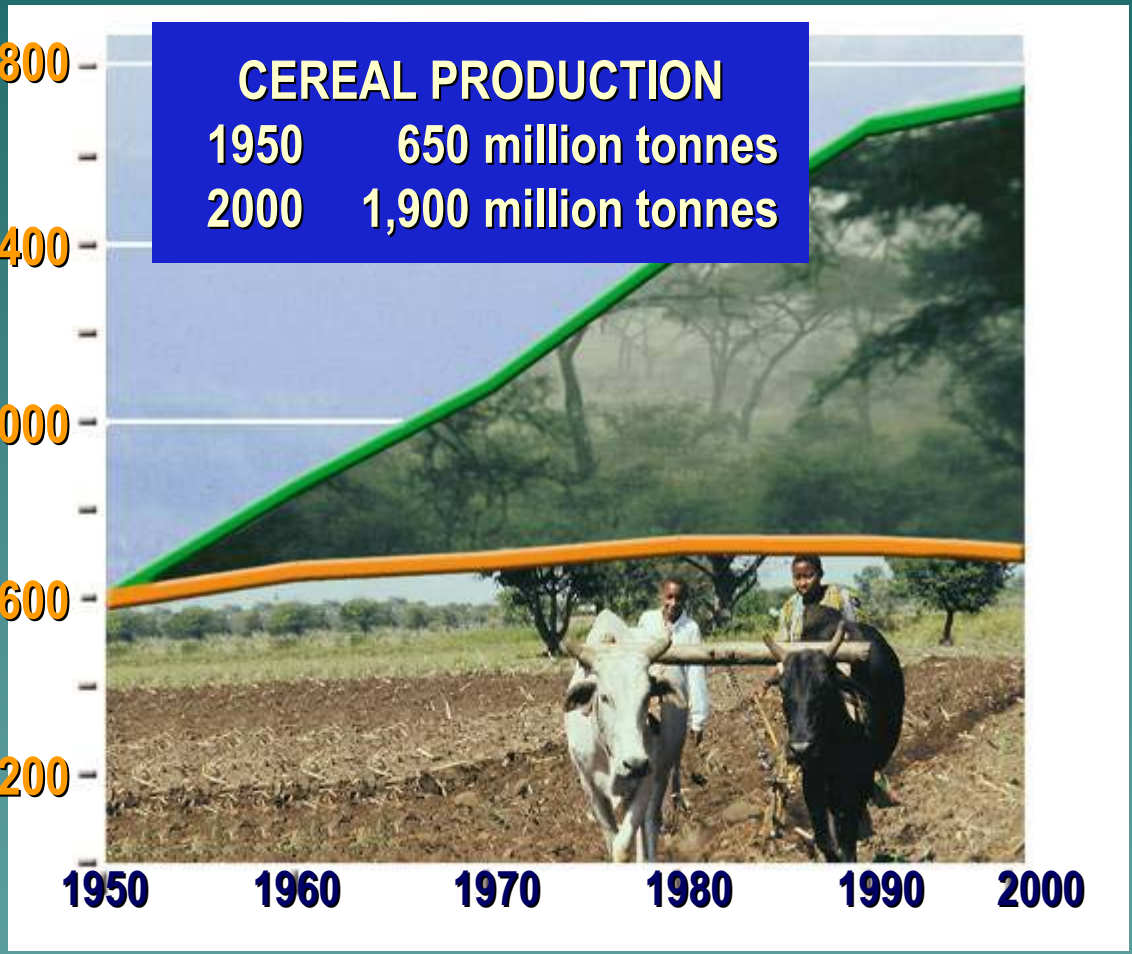
USDA Agricultural Outlook Forum
Arlington, VA
February 24, 2005

Green Revolution:
Changes in Factors of Production in Developing Countries of Asia

	Adoption of Modern varieties			Fertilizer Nutrient		
	Wheat	Rice	Irrigation	Use	Tractors	Cereal Production
	M ha / % area		million ha	million t	millions	million t
1961	0 / 0%	0 / 0%	87	2	0.2	309
1970	14 / 20%	15 / 20%	106	10	0.5	463
1980	39 / 49%	55 / 43%	129	29	2.0	618
1990	60 / 70%	85 / 65%	158	54	3.4	858
2000	70 / 84%	100 / 74%	175	70	4.8	962

Source: FAOSTAT, July 2002 and author's estimated on modern variety adoption, based on CIMMYT and IRRI data.

World Cereal* Production–Areas Saved Through Improved Technology, 1950-2000



LAND SPARED
1.1 billion ha

LAND USED
660 million ha

* Uses milled rice equivalents

Source: FAO Production Yearbooks and AGROSTAT

Hara Farms, Haryana

Poplar, 50 t/ha/year, 10-year cycle

Poplar, mangoes, wheat

Locally, 15,000 tons of timber logs a day are converted into ply, wood board, flush doors, etc, in 400 processing facilities over the last 15 years worth US$ 500 million a year

Wildlife Coming Back in the USA

High-Yield Forestry
Aracruz Cellulose, Brazil

World's leading producer of bleached eucalyptus pulp

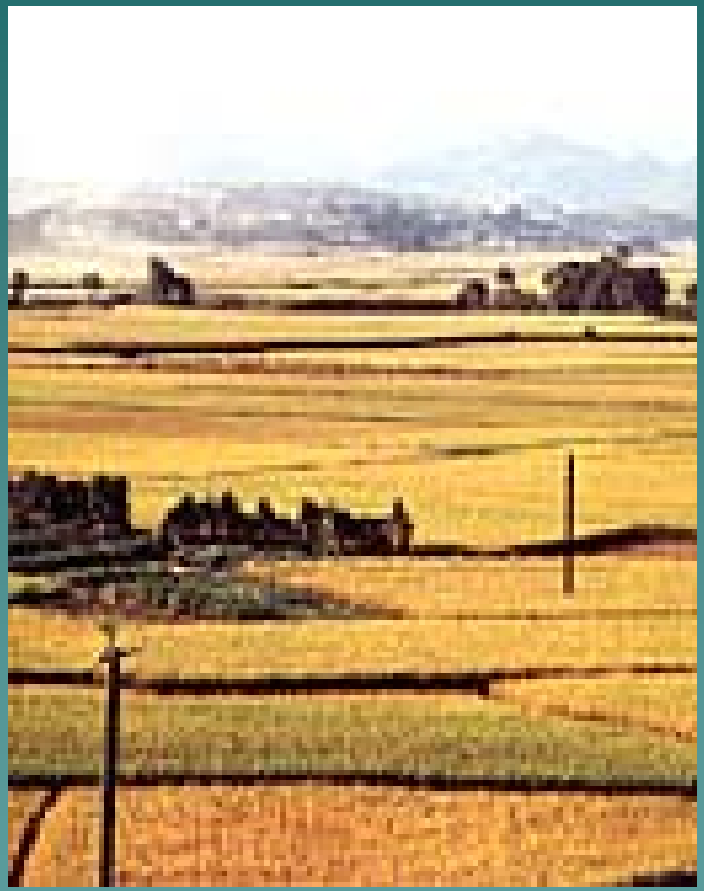
- 2.1 million tons, 31% of global supply in 2003
- Cutting cycle has been reduced from 8 to 6 years
- Pulp yield per ha has nearly doubled since the 1970s

High-yield agriculture & forestry will protect African wildlife

We will have to double the World Food Supply by 2050

- 85% of future growth in food production must come from lands already in production
- Limited potential for land expansions, except in the Americas and Sub-Saharan Africa
- Irrigation will remain crucial to meeting food demand

Chinese Agriculture in 2030

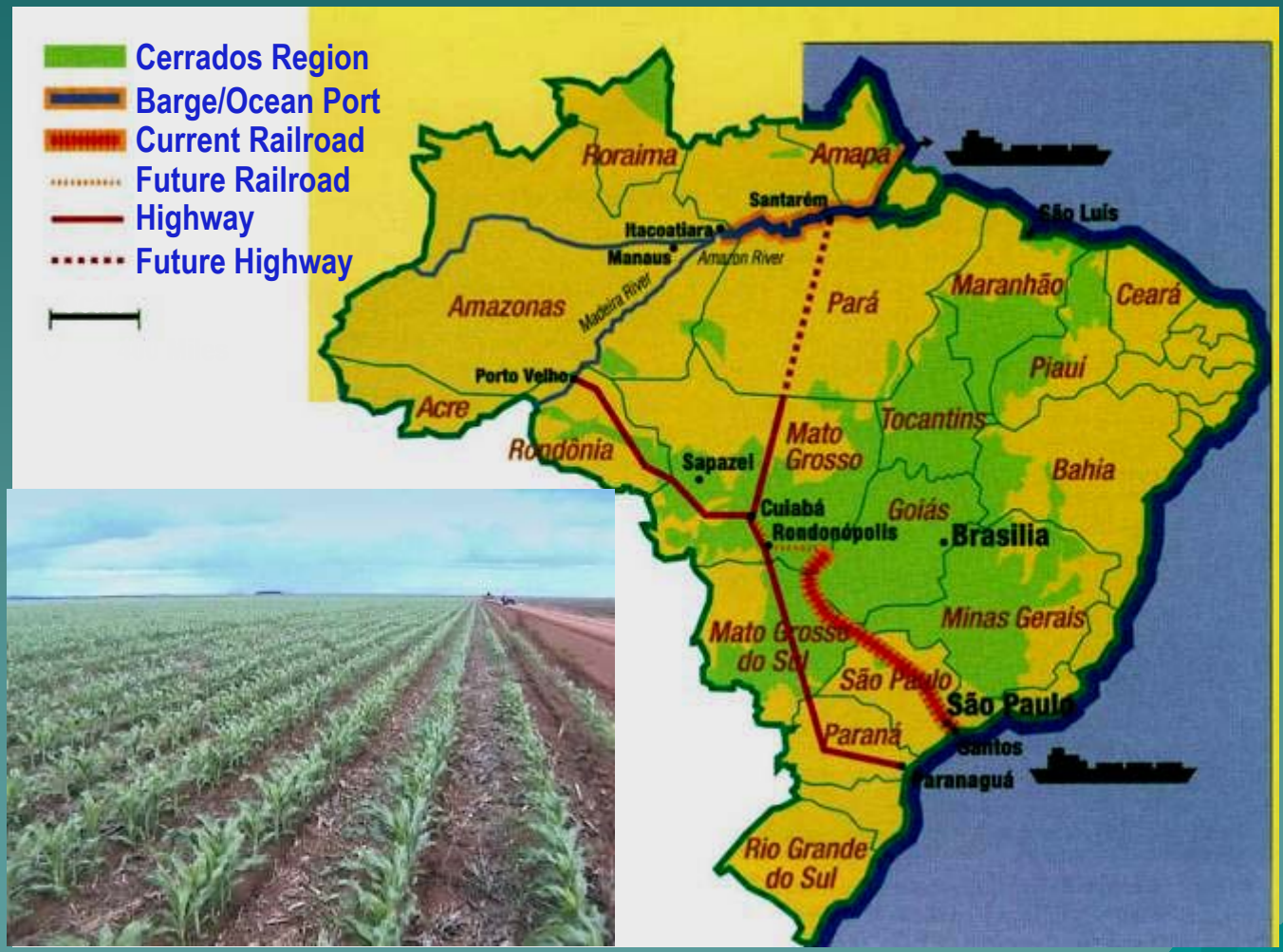


- 1.6 billion people
- 200 million fewer rural dwellers
- Arable land is likely to fall by 20%
- New science & technology will be critical to food security
- Far-reaching policy changes are needed in tax policy, land tenure, and farmer education
- Greater conservation of natural resources will be needed

Major Soybean Importers
(million metric tons)

	1998	2001	2002	2003
China	5.1	16.4	13.9	23.2
Netherlands	5.5	6.2	5.6	5.4
Japan	4.8	4.8	5.0	5.2
Germany	3.5	4.6	4.3	4.5
Mexico	3.5	4.5	4.4	4.2
Spain	3.2	3.4	3.4	3.1

Brazilian *Cerrados*



Source: Top Producer, Farm Journal Media, 2001

Improving Efficiency of Irrigated Agriculture

- 70% of global water withdrawals
- 17% of cultivated land
  (275 million ha, 200 million in developing countries)
- 40% of world food harvest
  (57% of cereal production)
- By 2030, FAO expects world's irrigated area to increase by 50 million ha.
- Planting on raised beds reduces water and fertilizer use by 20-25%

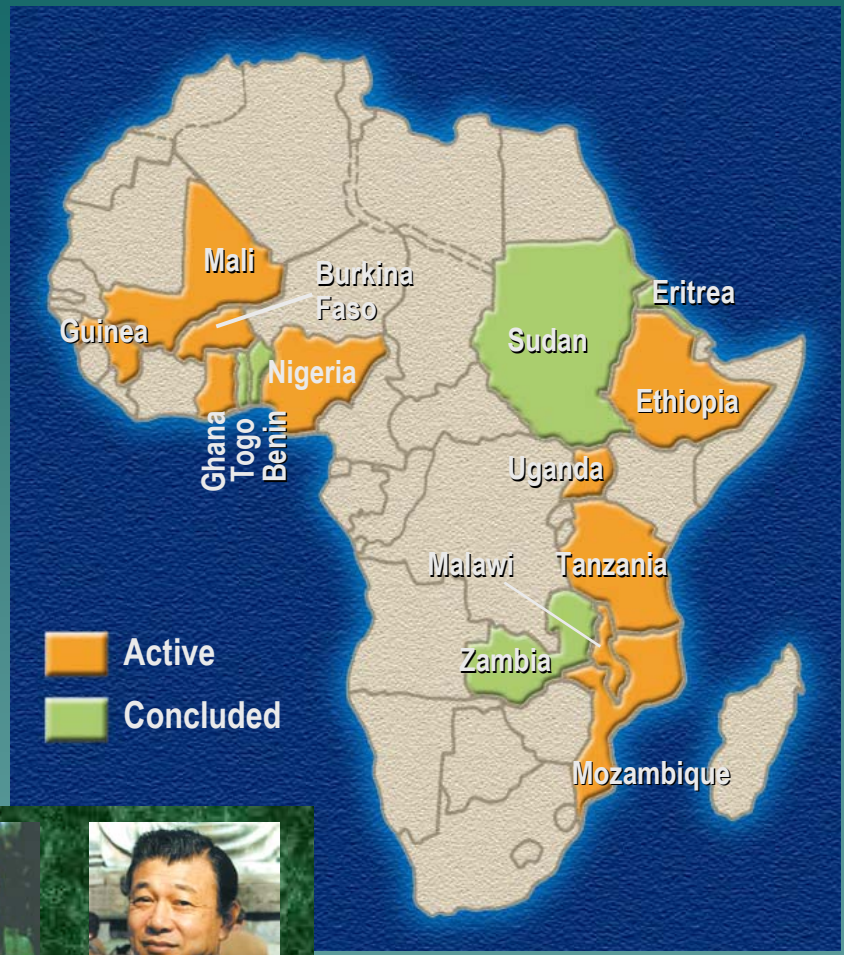
Conservation Tillage

- Saves labor and fuel
- Restores organic matter
- Controls weed
- Reduces erosion
- Conserves moisture

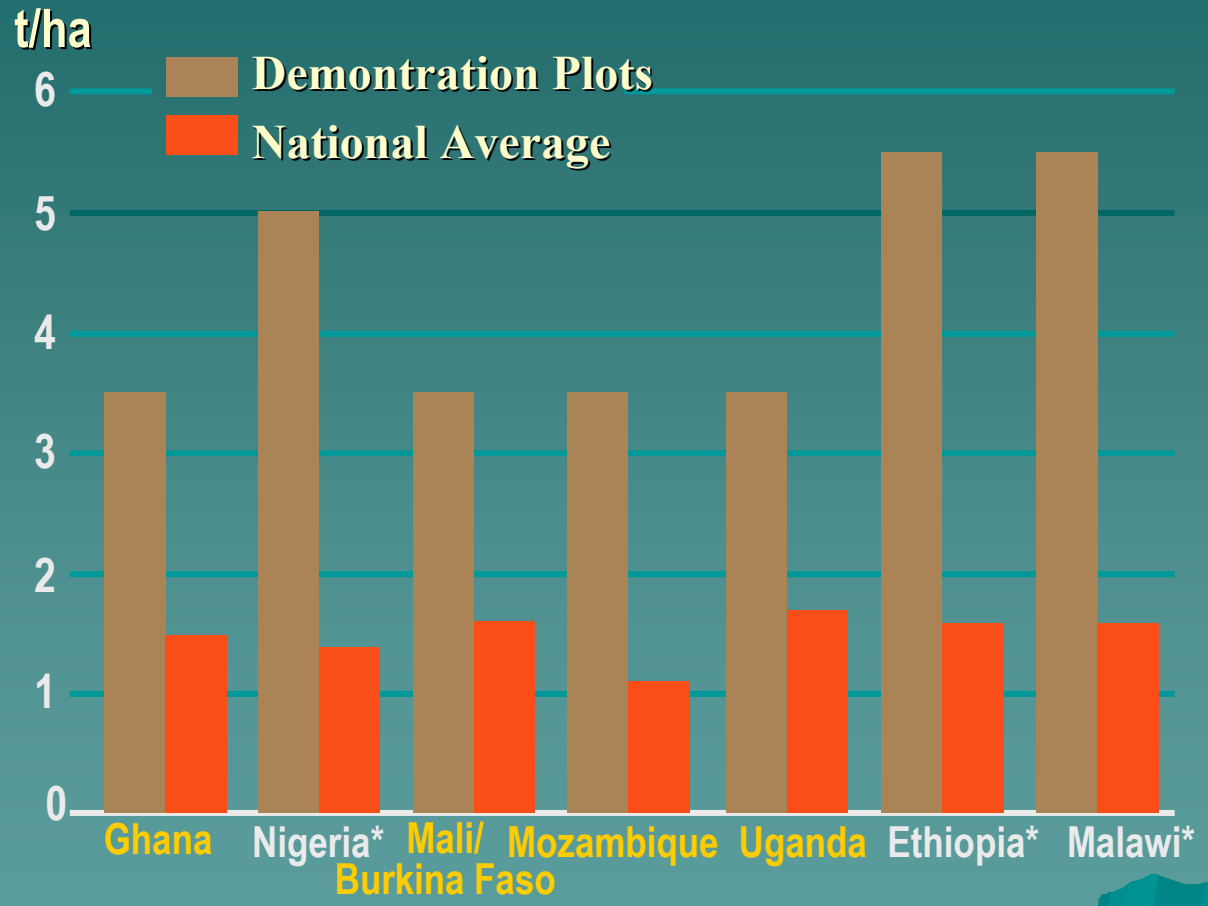
Sub-Saharan Africa is Our Greatest Challenge

Sasakawa-Global 2000 Program

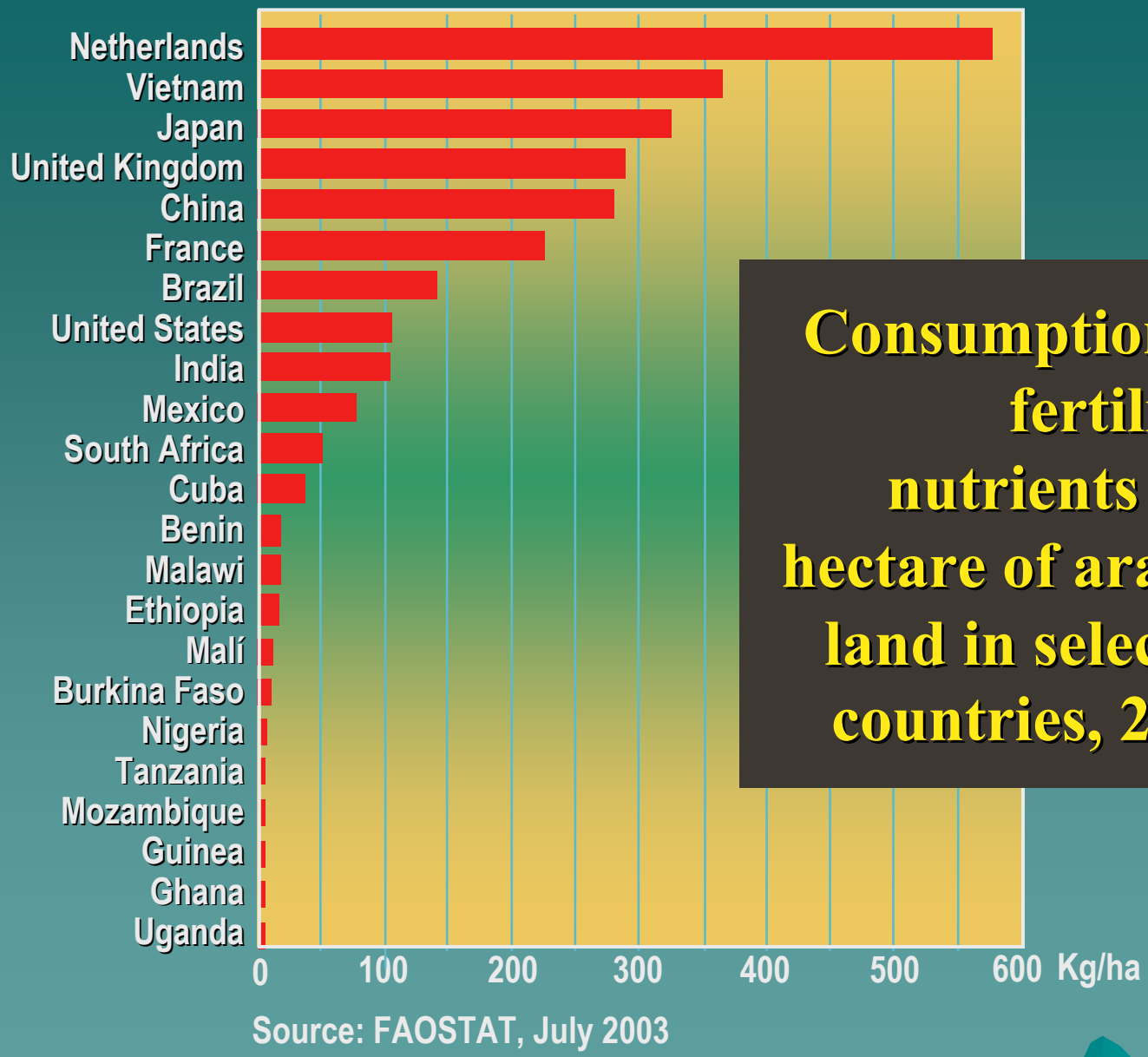
Started in 1896



Sasakawa-Global 2000 Maize Demonstration Yields



* Primarily using hybrids



Consumption of fertilizer nutrients per hectare of arable land in selected countries, 2002

Source: FAOSTAT, July 2003

Lack of Infrastructure Is Killing Africa

Kilometers of paved roads per million people in selected countries

	Km		Km
USA	20,987	Guinea	637
France	12,673	Ghana	494
Japan	9,102	Nigeria	230
Zimbabwe	1,586	Mozambique	141
South Africa	1,402	Tanzania	114
Brazil	1,064	Uganda	94
India	1,004	Ethiopia	66
China	803	Congo, DR	59

Source: Encyclopedia Britannica, 2002

“Marshall Plan” for Africa

2004
Global GMO Crop Coverage

	Area Million ha
USA	47.6
Argentina	16.2
Canada	5.4
Brazil	5.0
China	3.7
Paraguay	1.2
South Africa	0.5
India	0.5
9 other countries	0.9

	Crops Million ha
GM Soybean	48.4
GM Maize	19.3
GM Cotton	9.0
GM Canola	4.3

Total: 81 million ha (200 million acres)

Source: ISAAA, 2005

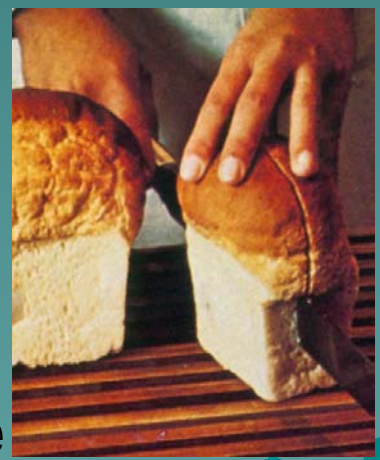
Bt Cotton

- 9 million ha around the world;
  6 million small farmers
- Excellent control of boll worms
- 25,000 mt reduction in insecticide use
- Substantial reduction in poisoning of farmers
- Significant increases in farmer profits

My "Biotechnology Dreams"

- Transfer rice's immunity to the rusts (*Puccinia* spp.) to other cereals—wheat, maize, sorghum, barley, etc

- Transfer bread wheat's proteins—gliadin and glutenin—for making superior dough for leavened bread to other cereals, especially rice and maize



Dark Clouds Gathering in World Wheat Economy

Per capita production declining since 1997

International germplasm exchange & testing declining

New disease threats emerging, e.g. stem rust

Soybean Rust Epidemic

- Two species; Asian type most aggressive
- 2001—Only small area in South America infected
- 2003—Brazilian producers lost US$ 1.3 billion (lost yield and fungicides)
- 2004—Reached southeast USA
- 2005-06 Expected to spread in USA
- Could cause US$ 4.5 billion in damage to U.S. soybean crop

Need to Restore Public Research Funding

- Green Revolution was the result of "public goods" research and investment
- Biotechnology is primarily driven by the private sector
- Maintaining a balance between public and private research is essential and healthy
- Public institutions focus on problems of the poor, help prepare future scientists, and help assure that the public interest is protected.

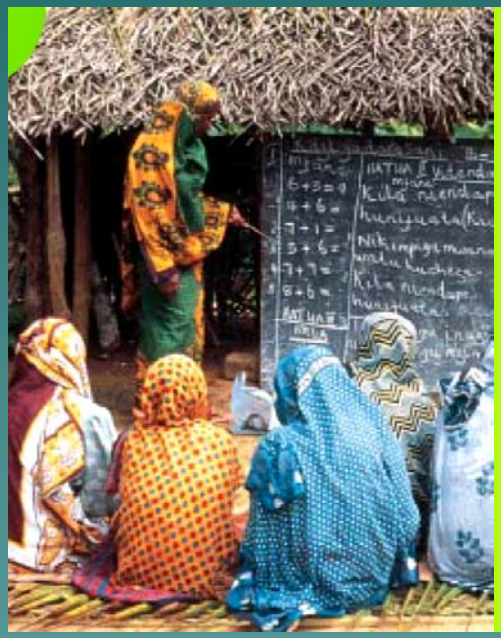
Agriculture and Peace

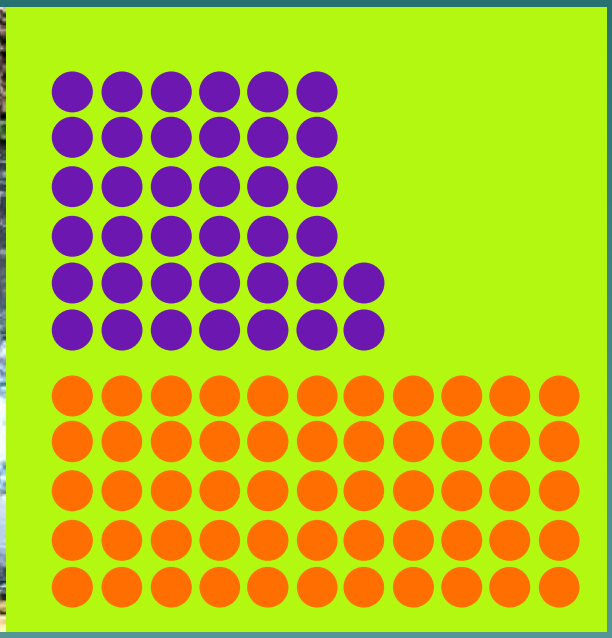
"Our policy…should be the revival of a working economy in the world, so as to permit the emergence of political and social conditions in which free institutions can exit."

George C. Marshall
June 7, 1947

- Only 8% of countries with the lowest levels of hunger are mired in conflict
- 56% of countries with highest levels of hunger have civil conflict
- World military budgets in 2004 exceed US$ 900 billion annually (USA accounts for 56% of total)
- In 2000, international support to agriculture reached lowest level in history and has only improved modestly since then

CUTTING ADULT ILLITERACY





Male
320 million

Female
550 million

TOTAL = 870 million people

+ 120 million primary school age children not in school

“You Cannot Build Peace on Empty Stomachs.”

John Boyd Orr
Nobel Peace Laureate
First FAO Director General